PiR2D Wiring vsn E Notes vsn B
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Introduction

The PiR2D Area Controller has an impressive number of sensors and actuators because it makes use of 2 Raspberry Pi Hat boards and an INA219 board that reads voltage and current when connected to a Grove I2C connector. The Raspberry 3.14-2 board is sourced from Mouser. The Weatherhat Pro board is sourced from BC Robotics. Some simple circuitry has been added to augment each board's capabilities. A soil moisture detector, a floor water detector and a microphone will next be added to the PiR2D. The sensors and actuators of each augmented board is shown in the table below:

Qty	Sensor	Qty	Actuator	Qty	Connector	Hat board
5	Digital Input Bits	3	Digital Output Bits	2	Grove I2C Conn.	3.14-2
2	Ambient Light	1	Local Heater	3	Analogue Conn.	3.14-2
1	Photo Camera	1	Solenoid			3.14-2
1	Video Camera					3.14-2
1	Motion Detector	1	Push Button			3.14-2
1	Ambient Temp.	3	LEDs (R/W/Y)			3.14-2
1	Remote Temp.	1	Heater (A-Resistor)			3.14-2
1	Ambient Temp.	1	Heater (W-Resistor)	1	UART Conn.	WeatherHat Pro
1	Ambient Humid.			1	Grove I2C Conn.	WeatherHat Pro
1	Ambient Barom.Pressure					WeatherHat Pro
2	Remote Temp. (SPI & 1 wire)	1	Servo Motor Connector			WeatherHat Pro
1	Wind Speed*					WeatherHat Pro
1	Wind Direction*					WeatherHat Pro
1	Rain Gauge*					WeatherHat Pro
3	Analog Input	1	Fan		5 Volt Input Conn.	WeatherHat Pro
1	USB Volt/Current					INA219

*NB Costs an additional CAD$100.00

All of the above sensors and actuators can be attached to the HAT boards by connectors or screw terminal posts. The USB Volt/Current is measured when an iPad, iPhone or tablet is plugged into the PiR2D to be charged via a USB connector.

Most of the additional circuitry was already developed and tested on the previous PiR2A board. All of the capabilities of the PiR2A area controller are included in the PiR2D. The goal is for the PiR2D area controller software to drive the PiR2A albeit with reduced functionality. The PiR2A software will hopefully make use of the PiR2A subset of the devices on the PiR2D. Forward and Backwards compatibility is the goal. Software has not yet been developed for a servo motor nor the UART nor the self diagnostics nor the symmetric diagnostics.

Placement of Connectors

The 3.14-2 is connected to the GPIO Connectors on the Raspberry Pi
The WeatherHat Pro is connected to the GPIO Connectors on the 3.14-2.
The Connectors on the WeatherHat Pro are all accessible because it is the external board.

The Connectors on the 3.14-2 are located so that they are not obscured by the WeatherHat Pro. On the 3.14-2, the Grove connectors, the Digital-In/Out screw terminals extend to the right and are not obscured by the WeatherHat Pro. Nor are the LEDs, push-button and future solenoid obscured. The A1,A2,A3 screw terminals on the 3.14-2 are positioned quite close to the matching A1,A2, A3 screw terminals on the WeatherHat Pro. The ribbon cable for the camera does not cover up any of the connectors on the 3.14-2. The Display cable slot is partially covered and will be difficult to use.

Symmetric Testing

The PiR2 area controllers have been designed to facilitate automatic testing of a PiR2D controller by another PiR2D controller. The arrangement of the ioDevices (sensors and actuators) is symmetric left to right. For example, 2 PiR2D controllers can be placed facing each other with the two ground screw terminals opposite those on the other PiR2D. Therefore the 5 digital inputs can easily be connected to the 5 digital outputs of the other PiR2D. The ambient temperature sensors and the heat-producing resistors (H-Resistor) will be almost touching one another. The two major LEDs (Red and White) face the two CDS ambient light sensors. The camera on each PiR2D can take a photo of the state of the visible ioDevices on the other PiR2 controller, although this requires that the two PiR2 controllers have 5 or 6 inches of separation. This separation only affects the testing of the ambient temperature and the heat-generating resistor opposite it. The “future” solenoid (described below) is positioned so that it can depress the Push Button of the other controller. The 3 analogue voltage sensors (A1, A2, A3) can all be joined together and driven by pin GPIO26 of the opposing PiR2. GPIO26 (A-Post) can optionally be turned on and off to test the two extreme voltages of each of the 3 analogue voltage sensors. To test the “I2C Bus Master” capability of each Grove connectors would require “I2C Bus Slave” software on the Raspberry Pi of its own (or the opposing) PiR2. No existing software is known to exist at this time.

I2C Testing

All I2C devices for the PiR2D are connected using Grove Connectors.

One way of testing the “I2C Bus Master” capability is by using a 6 to 10 inch TMP102-to-Grove ribbon cable. This cable can join a Grove connector of one PiR2D to the other PiR2D by placing the TMP102 thermometer close to the “Heat generating ” resistor (H-Resistor) of the other PiR2D when the two devices are 5 or 6 inches apart. This TMP102-to-Grove ribbon cable can be used in a “self-checking” mode by placing its TMP102 remote thermometer close to its own “heat-generating” resistor. It should also be mentioned that a heat-generating resistor (W-Resistor) has been included on the WeatherHat Pro. This 100 ohm “heat-generating” resistor is optionally (solder bridge A) connected between the GPIO26 (pin 37) and Ground (pin 39) which are positioned very close to the thermometer on the WeatherHat Pro.

Two “TMP102-to-Grove” ribbon cables can be used to “link” the I2C Grove connector on one WeatherHat Pro of one PiR2D to the WeatherHat Pro on the other PiR2D. The “link” is physically made by placing the TMP102 at the end of the cable very near the “W-Resistor” on the WeatherHat Pro of the other PiR2. This “link” permits one PiR2 to test the “variable ambient temperature” of the other PiR2. An optional “A-Resistor” has been included on the 3.14-2. It can be used to heat the BME280 ambient temperature sensor on the WeatherHat Pro from the back side. Because the PiR2D is comprised of both Hats, the BME280 Temp/Press/Humidity sensor can be heated up by 2 “heat-generating” resistors (A-Resistor and W-Resistor), one on each side of the WeatherHat Pro board for testing purposes.

Diagnostics

The PiR2D has been designed so that its components can do many self-diagnostic tests. These tests are accomplished by connecting "actuator" devices to corresponding "sensing" devices. A PiR2D can also be tested by another "good" PiR2D. Such tests need at least one (preferably 3) TMP102-to-Grove cable. Each Grove connector can diagnose errors in the 3 heater resistors, or in the INA219. (The INA219 measures the current that can charge an iPhone, iPad or tablet.)

Process Control Thermostat

The W-Resistor or A Resistor can be used to simulate a thermostat using "process control software" as follows. The ambient temperature detected by the BME280 can be compared to the "desired temperature range" defined by the "temperature set-point". If the ambient temperature is too low (lower than the range), the PiR2D can "turn on" the W-Resistor (or H-Resistor). This will warm up the ambient temperature local to the BME280. When the ambient temperature reaches the top of the range, the W-Resistor is turned off permitting the "ambient temperature" to cool down until it is below the "desired temperature range" again. In this manner the W-Resistor and the ambient temperature portion of the BME280 can be tested. A TMP102-to-Grove cable can be used to permit the PiR2D to simulate this functionality. Similarly, the H-Resistor can be used with the TMP102 to do the same.

Cautions regarding the BME280 and a Solenoid

The manufacturer of the WeatherHat Pro warns that heat from the Raspberry Pi processor will increase the temperature of the BME280 thermometer. The 3.14-2 board in the PiR2D will shield the BME280 from the Raspberry Pi processor. The elevated current drawn by the solenoid occurs very seldom. But the three boards that comprise the PiR2D will increase the current drawn from the 5 Volt supply. For this reason, a 1 amp 5 Volt power supply is recommended to power the PiR2D and the Raspberry Pi. Such a power supply will also be able to run a cooling fan.

The future solenoid is positioned on the most external edge of the 3.14-2 where it could be used as a physical actuator for some future device. The solenoid is positioned so that it can depress the opposing push button during testing.

These solenoids are normally used to unlock a door, via a Push Button for example.

BC Robotics SKU: **ROB-021** CAD $ 13.95
Volt: 18-24v (.25a)
(throw: .217 inch/ 5.5 mm)

Jameco SKU: **2231099** US $ 6.95
Pull Solenoid 3-12 V (1.43-14.3 amps) Travel: 1.5mm
Voltage: 12v Amps: 650m

Materials Needed

For Symmetric Testing

2 PiR2D area controllers
2 TMP102-to-Grove 10” ribbon cables
2 3-1 10” ribbon cables (3 wires at one end joined to 1 female GPIO connector)
2 12-12 5” ribbon cables (for DigIn / DigOut connection)

For Normal Operation

1 3-3 5” ribbon cable (3 wires at each end)
2 4 wire cables with male Grove connectors at each end
1 4 wire cable with a male Grove connector at one end
2 TMP102-to-Grove 30” ribbon cables

Posts, Wire Colors, Push Button, Connectors and Solder Bridges

The Push Button is ON when depressed.
There are 3 Solder Bridges and 2 posts on the 3.14-2.
Wire colors are:

Ground	Green
3v3	Pink
5V	Red
other	various

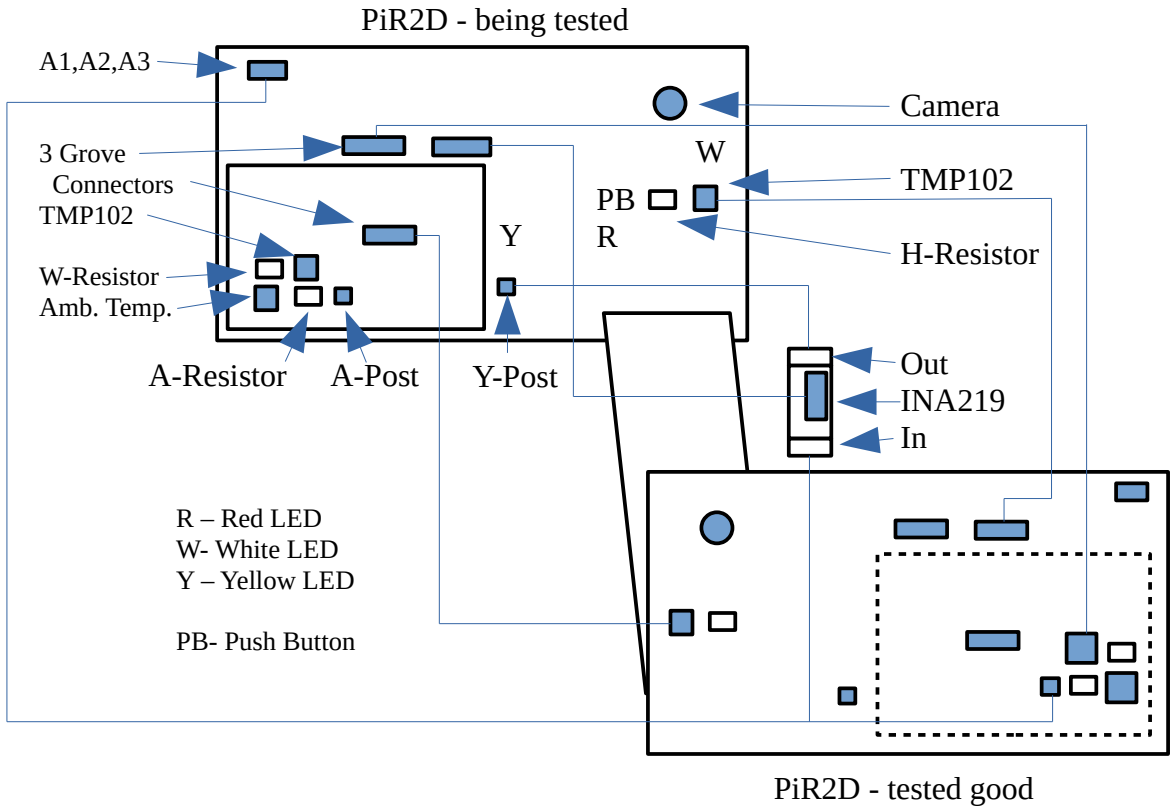
Name	**Purpose**
Heat	solder this bridge to enable the H-Resistor to heat the TMP36 thermometer. The H-Resistor is driven by DigOut0 (GPIO17).
YLED	solder this bridge to light the YLED when the DigOut0 (GPIO17 in on)
Y-Post	set high (“1”) to light the Yellow LED
A-Post	driven high (“1”) by GPIO26 (GPIO pin 37)
A	solder this bridge to enable GPIO26 to drive the A-Resistor The A-Resistor is located “behind” the WeatherHat Pro’s BME180.

Connector and Resistors

All Resistors are 1/8 watt except the 100 ohm Heater resistors which are ¼ watt.
A Grove expansion board is available to allow additional I2C devices to be connected.

Name	**Description**
Grove	female I2C connector
A1,2,3	Screw-Type connector for 3 wires
DigIn/Out	Screw-Type connector for 12 wires

Diagram of Symmetric Testing of 2 PiR2Ds



NB During testing of both PIR2D devices:

Solder bridge HEAT should be CLOSED
Solder bridge A should be OPEN
Solder bridge YLED should be OPEN
A second set of cables is needed to perform symmetric testing simultaneously.

Symmetric Test Pairing

1. A-Post drives A1,A2,A3 and feeds amps into the USB of INA219
2. The INA219 feeds amps into Y-Post which drives the Y-LED
3. Good TMP102 heated by test H-Resistor is measured by good Grove-2
4. Grove-1 measures TMP102 (which is heated by A-Resistor & W-Resistor)
5. Grove-2 measures amps passing through the INA219
6. Grove-3 measures TMP102 (heated by the H-Resistor)
7. Each DigIn line monitors the DigOut line on the other PiR2D (including 3.3V and 5V)
8. The test YLED is driven by the INA219 via the Y-Post

Sources

Source 1: http://ephotocaption.com/a/146/146.html Components for the PiR2D
Source 2: PiR2D_WiringE.odg Wiring Drawing in Article 146

/PiR2D_WiringE_NotesB.odt